(19) Europäisches Pat ntamt
European Patent Office
Offic urop´en d s brev ts

(11) EP 0 903 937 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
24.03.1999 Bulletin 1999/12

(51) Int Cl.6: H04N 5/44

(21) Application number: 98307098.8

(22) Date of filing: 03.09.1998

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 22.09.1997 JP 257345/97

(71) Applicant: ALPS ELECTRIC CO., LTD.
Ota-ku Tokyo 145 (JP)

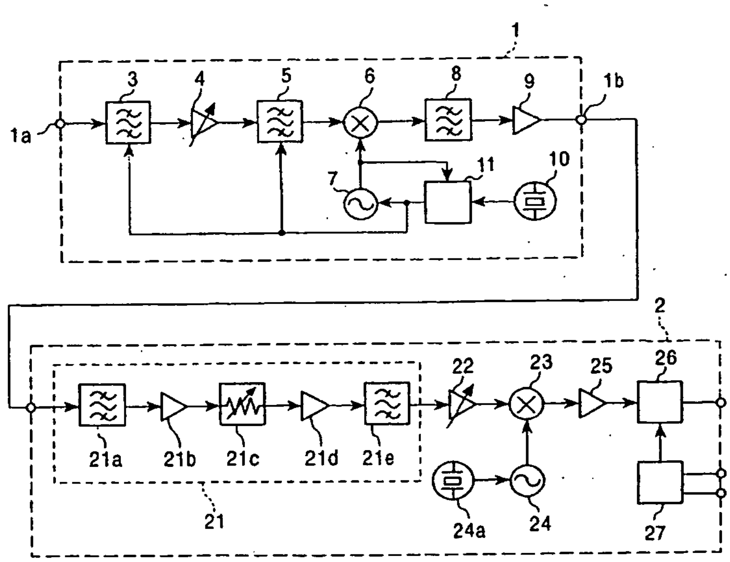
(72) Inventors:
- Takayama, Akira
Soma-shi, Fukushima-ken (JP)
- Tadachi, Akio
Soma-shi, Fukushima-ken (JP)
- Tanaka, Ryoichi
Soma-shi, Fukushima-ken (JP)

(74) Representative: Kensett, John Hinton
Saunders & Dolleymore,
9 Rickmansworth Road
Watford, Hertfordshire WD1 7HE (GB)

(54) Digital television signal receiving tuner system

(57) A digital television signal receiving tuner system is formed of a tuner (1) and an intermediate frequency circuit (2). The tuner has a first mixer (6) that converts a television signal into a first intermediate frequency signal, which is a television intermediate frequency signal. The intermediate frequency circuit has a second mixer (23) that converts the first intermediate frequency signal into a second intermediate frequency signal. The intermediate frequency circuit is provided with an adjacent-band attenuation device (21) at a stage before the second mixer. The adjacent-band attenuation device attenuates the band levels of channels located adjacent to the first intermediate frequency signal by 60 dB or greater relative to the band level of the first intermediate frequency signal. As a consequence, upon receiving digital television signals, interference from analog television signals is eliminated, and the generation of distortion is suppressed even in a wide gain control range.

FIG. 1



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Description

[0001] The present invention relates to a tuner system that receives digital television signals transmitted via ground waves.

[0002] In digital television broadcasting, satellite broadcasting and cable television (CATV) broadcasting have already been put into practical use, and ground broadcasting is also being planned for practical use. Digital television broadcasting methods vary among countries and regions, and the Orthogonal Frequency Division Multiplex (OFDM) method is employed in Europe and Japan. In the OFDM method, a few thousands of carrier waves are provided for the broadcasting band of each channel of a conventionally used ground television system and are modulated with, for example, a baseband signal according to the Quadriphase Phase Shift Keying (QPSK) method and then transmitted.

[0003] In the OFDM digital television system, broadcasting frequency bands allocated to conventionally used analog television broadcasting are used, and thus, channels in which digital television signals are transmitted are located adjacent to channels in which analog television signals are transmitted.

[0004] Accordingly, analog television signals may be mixed with digital television signals. In this state, digital television signals may interfere with an analog television receiver. To avoid this situation, in compliance with the broadcasting standards, the level of digital television signals is reduced by an amount in the range of 20 dB to 35 dB relative to that of analog television signals before they are transmitted. A receiver of digital television signals that sufficiently receives signals of levels from -96 dBm to -20 dBm at its receiving input terminal without any trouble is also demanded. The signal level receivable by a digital television signal receiver is thus required to have a dynamic range as wide as 76 dB.

[0005] As discussed above, digital television signals may be transmitted with analog television signals, for example, channels in which digital television signals are transmitted are located adjacent to those in which analog television signals are transmitted. In this case, analog television signals may disadvantageously interfere with a digital television signal receiver.

[0006] In response to a wide dynamic range of digital tel vision signals, such as 76 dB, a digital television signal receiver is required to have a wide gain control range and also to suppress distortion caused by gain control.

[0007] Accordingly, it is an object of the present invention to eliminate interference of analog television signals upon receiving a digital television signal and to suppress the generation of distortion even in a wide gain control range.

[0008] In order to achieve the above object, according to the present invention, there is provided a digital television signal receiving tuner system including a first mixer for converting a television signal to a first intermediate frequency signal. Adjacent-band attenuation means, which is disposed at a stage after the first mixer, attenuates a signal of a channel located adjacent to a frequency band of the first intermediate frequency signal by 60 dB or greater relative to the first intermediate frequency signal. A second mixer, which is disposed at a position after the adjacent-band attenuation means, converts the first intermediate frequency signal into a second intermediate frequency signal having a frequency lower than the frequency of the first intermediate frequency signal.

[0009] In the aforementioned digital television signal receiving tuner system, the adjacent-band attenuation means may include a SAW filter for attenuating the signal of the adjacent channel, and a compensation amplifier disposed at a stage after the surface acoustic wave filter and compensates for insertion losses caused by the surface acoustic wave filter.

[0010] The aforementioned digital television signal receiving tuner system may further include a first variable-gain amplifier disposed at a stage before the first mixer, and a variable attenuator disposed at a stage after the compensation amplifier.

[0011] In the aforementioned digital television signal receiving tuner system, a second variable-gain amplifier may be provided in place of the compensation amplifier and the variable attenuator.

[0012] Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram illustrating a digital television signal receiving tuner system according to the present invention;

Fig. 2 is a characteristic diagram illustrating adjacent-channel attenuation means for use in a digital television signal receiving tuner system according to the present invention;

Fig. 3 is a circuit diagram illustrating adjacent-channel attenuation means for use in a digital television signal receiving tuner system according to the present invention; and

Fig. 4 illustrates a modification made to the adjacent-channel attenuation means for use in a digital television signal receiving tuner system according to the present invention.

[0013] A digital television signal receiving tuner system of the present invention is now described with reference to Fig. 1.

[0014] In the following description, digital television signals and analog television signals are simply referred to as "television signals" unless they are required to be distinguished.

[0015] A digital television signal receiving tuner system of the present invention is formed of a tuner 1 and an intermediate frequency circuit 2. The tuner 1, as well as a tuner for receiving analog television signals, has an input tuning circuit 3, a high frequency amplifier 4, an

interstage tuning circuit 5, a first mixer 6, a first local oscillator 7, an intermediate frequency tuning circuit 8, and an intermediate frequency amplifier 9. The high frequency amplifier 4 is formed of a first variable-gain amplifier in which the gain is controlled in accordance with a control voltage from an automatic gain voltage generating circuit (not shown).

[0016] For convenience, the input tuning circuit 3, the high frequency amplifier 4, the interstage tuning circuit 5, and the first mixer 6 are indicated by one system. In practice, however, two systems used for VHF television signals and UHF television signals are provided for the tuner.

[0017] A television signal is input into a tuner input terminal la, and a desired channel of the television signal is selected and amplified in the input tuning circuit 3, the high frequency amplifier 4, and the interstage tuning circuit 5. The amplified television signal is then input into the first mixer 6 in which it is mixed with a local oscillation signal output from the first local oscillator 7 and is converted into a first intermediate frequency signal (approximately 36 MHz in the Europe television system). The first intermediate frequency signal passes through the intermediate frequency tuning circuit 8 and the intermediate frequency amplifier 9 and is output from a tuner output terminal 1b.

[0018] Not only digital television signals, but also analog television signals are input into the tuner input terminal la. Accordingly, only a desired digital television signal is selected by the input tuning circuit 3 and the interstage tuning circuit 5 and is converted into a first intermediate frequency signal by being mixed with a local oscillation signal. Thus, the oscillation frequency of the local oscillator 7 is controlled by a PLL circuit 11 provided with a reference oscillator 10. The PLL circuit 11 is provided with a tuning voltage generating circuit (not shown) for controlling the tuning frequency of the input tuning circuit 3 and the interstage tuning circuit 5.

[0019] The intermediate frequency circuit 2 generates an 8-bit baseband signal from the first intermediate frequency signal obtained in the tuner 1. The intermediate frequency circuit 2 has adjacent-band attenuation means 21, a first variable-gain intermediate frequency amplifier 22, a second mixer 23, a second local oscillator 24, a second intermediate frequency amplifier 25, an analog-to-digital (A/D) converter 26, and a clock oscillator 27. The adjacent-band attenuation means 21 possesses characteristics in which the frequency bands of the adjacent channels are attenuated by 60 dB or greater, as illustrated in Fig. 2, assuming that the channel of the first intermediate frequency signal, which is a digital television signal to be received, is located adjacent to channels of analog television signals. By virtue of the above-mentioned characteristics, even if the level of a digital television signal at the tuner input terminal la is lower than the levels of the adjacent analog television signals by 35 dB, the level of the digital television signal at the input terminal of the second mixer 23 becomes higher than the adjacent analog television signals by 25 dB.

[0020] The first intermediate frequency signal output from the adjacent-band attenuation means 21 is amplified in the first intermediate frequency amplifier 22 and is then input into the second mixer 23. In the second mixer 23, the first intermediate frequency signal is mixed with a local oscillation signal output from the second local oscillator 24 and is converted into a second intermediate frequency signal of approximately 4 MHz. To stabilize the frequency, the second local oscillator 24 is provided with a crystal oscillator portion 24a. The second intermediate frequency signal is amplified in the second intermediate frequency amplifier 25 to a predetermined level and is input into the A/D converter 26. In the A/D converter 26, the second intermediate frequency signal is sampled by a clock signal having approximately 18 MHz output from the clock oscillator 27, thereby generating an 8-bit baseband signal. The baseband signal is demodulated and decoded in a baseband processing circuit (not shown) to extract a video signal and an audio signal. Because of the QPSK demodulation in the baseband processing circuit, not only a clock signal of 18 MHz, but also a clock signal of 36 MHz are output from the clock oscillator 27.

[0021] The configuration of the adjacent-band attenuation means 21 is discussed in detail with reference to Fig. 3. The adjacent-band attenuation means 21 is formed of a first surface acoustic wave (SAW) filter 21a, a first compensation amplifier 21b, a variable attenuator 21c, a second compensation amplifier 21d, and a second SAW filter 21e, and these elements are sequentially connected. The attenuation means 21 from the output terminal of the first SAW filter 21a to the output terminal of the second SAW filter 21e is formed of a balanced circuit.

[0022] The first SAW filter 21a and the second SAW filter 21e have substantially similar characteristics, and the respective filters 21a and 21e attenuate the frequency bands of the adjacent channels by substantially 30 dB or greater. The first compensation amplifier 21b and the second compensation amplifier 21d compensate for insertion losses incurred in the transmission bands of the first SAW filter 21a and the second SAW filter 21e, respectively. In this manner, the first SAW filter 21a is disposed at a stage before the first compensation amplifier 21b, thereby reducing the generation of distortion in the first compensation amplifier 21b. The second compensation amplifier 21d is disposed at a stage before the second SAW filter 21e, thereby suppressing the noise frequency (NF) caused by the second SAW filter 21e.

[0023] Direct-current (DC) blocking capacitors 28, 28 connect th first SAW filter 21a and the first compensation amplifier 21b, the second compensation amplifier 21d and the second SAW filter 21e, and the second SAW filter 21e and the second intermediate frequency amplifier 22. The variable attenuator 21c is provided

with a PIN diode 29, which is connected in such a manner that it shunts two balanced lines. A fixed voltage (for example, a power supply voltage of 5V) is applied to the cathode via a bias resistor 30, while a control voltage output from a gain control voltage generating circuit (not shown) is supplied to the anode via a resistor 31. The PIN diode 29 and the second compensation amplifier 21d are connected via DC blocking capacitors 32, 32. The PIN diode 29 and the first compensation amplifier 21b are connected via impedance matching resistors 33, 33 and DC blocking capacitors 34, 34, which are respectively connected in series to each other.

[0024] Upon supplying a control voltage to the anode of the PIN diode 29, the adjacent-band attenuation means 21 is able to perform control in cooperation with the high frequency amplifier 4 of the tuner 1 and the first intermediate frequency amplifier 22 so that the level of an input digital television signal can be maintained at a dynamic range of approximately 76 dB.

[0025] If the bands of the adjacent channels are adequately attenuated by approximately 60 dB or greater only by the first SAW filter 21a, the second compensation amplifier 21d and the second SAW filter 21e may be omitted. The first compensation amplifier 21b and the variable attenuator 21c may be substituted with a second variable-gain amplifier 21f, and the first SAW filter 21a and the second variable-gain amplifier 21f may form the adjacent-band attenuation means 21, as illustrated in Fig. 4.

[0026] As is seen from the foregoing description, the digital television signal receiving tuner system of the present invention offers the following advantages.

[0027] The adjacent-band attenuation means is interposed between the first mixer and the second mixer to attenuate signals of the channels adjacent to the frequency band of a first intermediate signal by 60 dB or greater relative to the first intermediate frequency signal. Thus, in the second mixer, the interference of analog television signals of the adjacent channels is reduced. Since the adjacent-band attenuation means is disposed at a stage after the first mixer, known elements for receiving analog television signals can be used for the first mixer and the preceding elements, thereby simplifying the design of the digital television signal receiving tuner system.

[0028] Signals of the adjacent channels are attenuated by using the first and second SAW filters, and insertion losses caused by the first and second SAW filters are compensated with the first and second compensation amplifiers, respectively, thereby ensuring the intensity of the first intermediate frequency signal. The first compensation amplifier is disposed at a stage after the first SAW filter, thereby reducing distortion generated in the first compensation amplifier caused by analog television signals in the adjacent channels.

[0029] The first variable-gain amplifier is located at a stage before the first mixer, and the variable attenuator is placed at a stage after the first compensation amplifier, thereby increasing the dynamic range of receiving signals.

[0030] In place of the first compensation amplifier and the variable attenuator, a second variable-gain amplifier may be used, thereby simplifying the circuit.

Claims

1. A digital television signal receiving tuner system comprising:

   a first mixer for converting a television signal to a first intermediate frequency signal;
   adjacent-band attenuation means for attenuating a signal of a channel located adjacent to a frequency band of the first intermediate frequency signal by 60 dB or greater relative to the first intermediate frequency signal, said adjacent-band attenuation means being disposed at a stage after said first mixer; and
   a second mixer for converting the first intermediate frequency signal into a second intermediate frequency signal having a frequency lower than the frequency of the first intermediate frequency signal, said second mixer being disposed at a stage after said adjacent-band attenuation means.

2. A digital television signal receiving tuner system according to claim 1, wherein said adjacent-band attenuation means comprises a surface acoustic wave filter for attenuating the signal of the adjacent channel, and a compensation amplifier disposed at a stage after said surface acoustic wave filter and compensates for insertion losses caused by said surface acoustic wave filter.

3. A digital television signal receiving tuner system according to claim 2, further comprising a first variable-gain amplifier disposed at a stage before said first mixer, and a variable attenuator disposed at a stage after said compensation amplifier.

4. A digital television signal receiving tuner system according to claim 1, further comprising a first variable-gain amplifier disposed at a stage before said first mixer, wherein said adjacent-band attenuation means comprises a surface acoustic wave filter for attenuating the signal of the adjacent channel, and further comprising a second variable-gain amplifier disposed at a stage after said surface acoustic wave filter.

FIG. 1

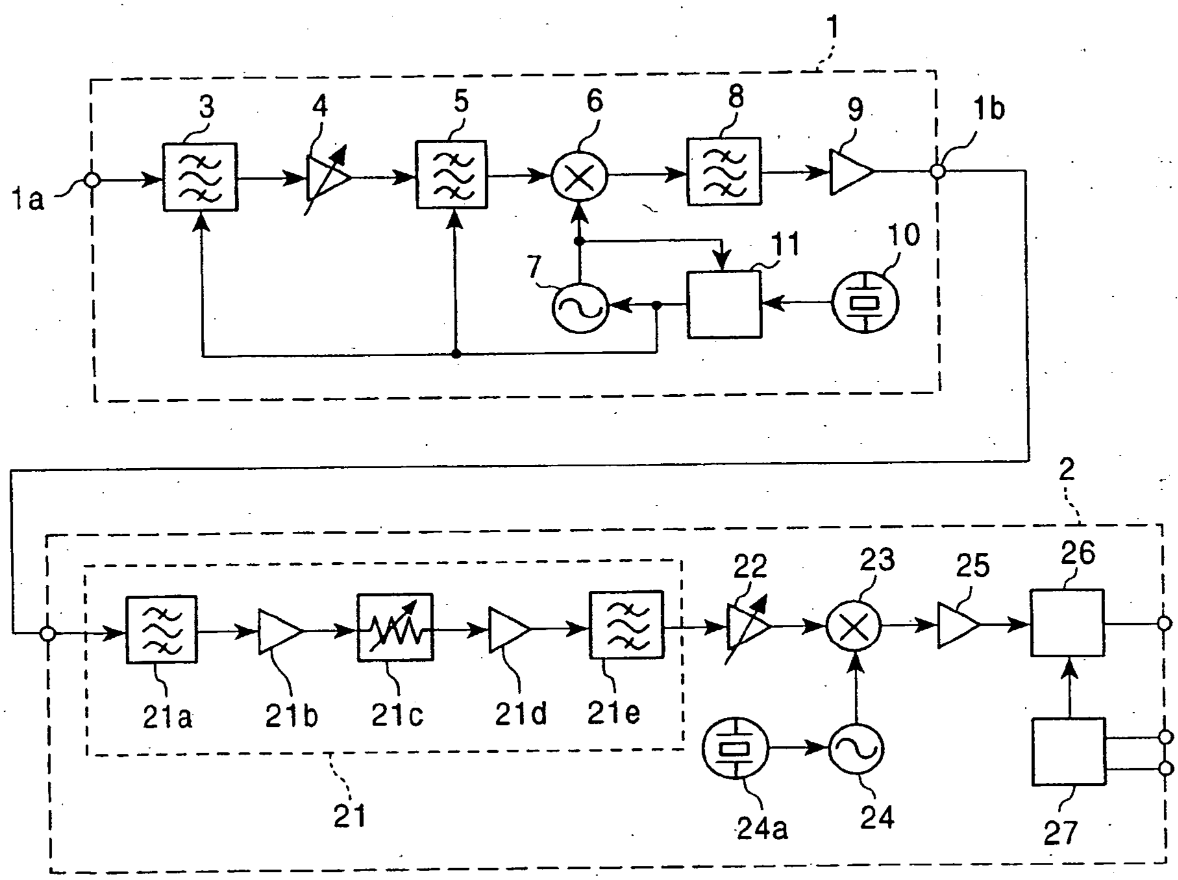


FIG. 2

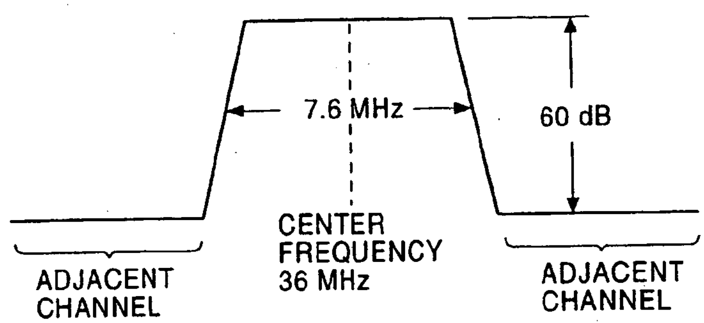


FIG. 3

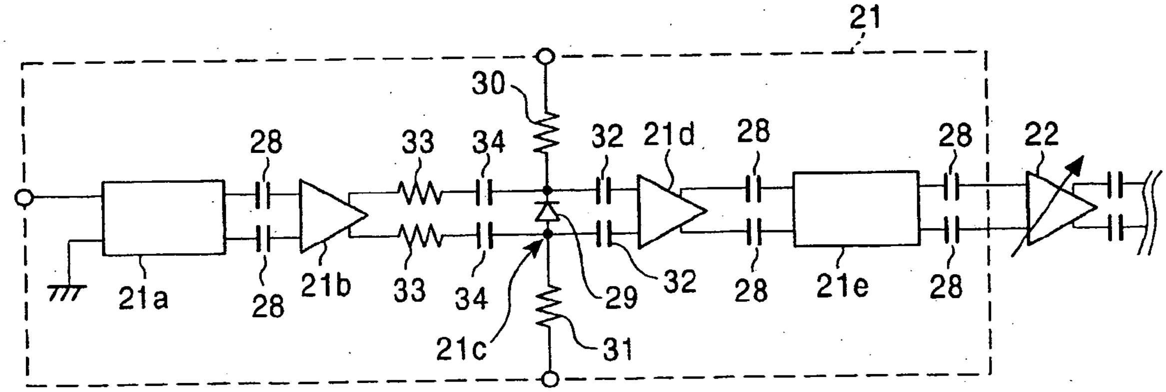
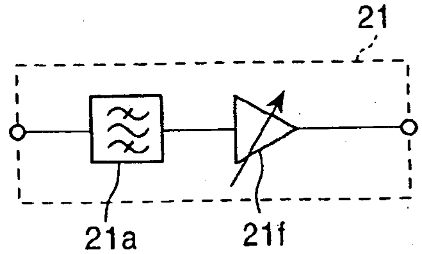


FIG. 4



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(11) EP 0 903 937 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
17.11.1999 Bulletin 1999/46

(43) Date of publication A2:
24.03.1999 Bulletin 1999/12

(21) Application number: 98307098.8

(22) Date of filing: 03.09.1998

(51) Int Cl.[6]: H04N 5/44

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Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 22.09.1997 JP 25734597

(71) Applicant: ALPS ELECTRIC CO., LTD.
Ota-ku Tokyo 145 (JP)

(72) Inventors:
- Takayama, Akira
  Soma-shi, Fukushima-ken (JP)
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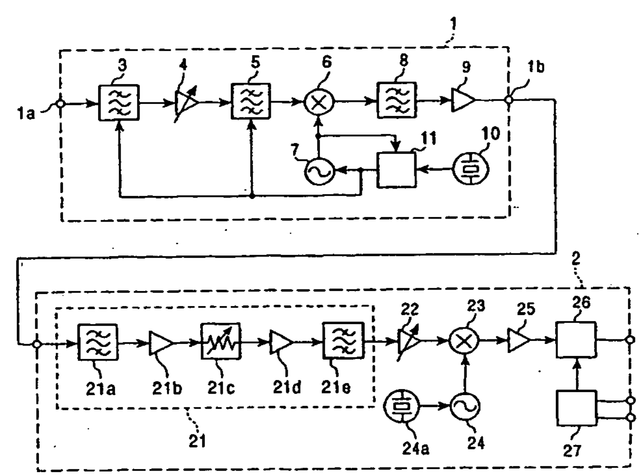
FIG. 1



EP 0 903 937 A3

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EUROPEAN SEARCH REPORT

Application Number
EP 98 30 7098

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP 0 769 873 A (PARADYNE CORPORATION) 23 April 1997 (1997-04-23) * the whole document *	1-4	H04N5/44
A	US 5 636 252 A (PATEL C. ET AL) 3 June 1997 (1997-06-03) * column 9, line 21 - column 10, line 56 *	1-4	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
H04N
H04L
H03D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24 September 1999	Verschelden, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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